THE PERSONAL ANALOG COMPUTER

Instruments for Instruction and Training

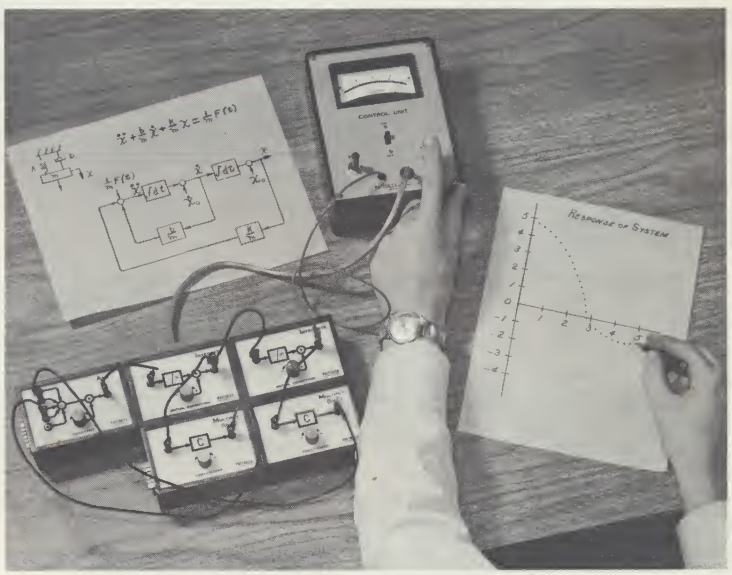
The concept of a Personal Analog Computer was proposed and specified at Case Institute of Technology by Professor James Reswick. Realizing that the use of analogue techniques greatly strengthened the students knowledge of physical systems, as well as their associated mathematics, he suggested the development of a "dormitory computer" specifically for student use. Each student would have his own portable unit, to use when and where he wanted to experiment. The use of the computer would require no special knowledge. The culmination of this proposal was the Personal Analog Computer.

What is the Personal Analog Computer

The Personal Analog Computer is an electronic demonstration system which utilizes individual miniature analog computer modules for visually representing and solving mathematical equations. Each of these modules performs one of the three basic mathematical operations, adding, multiplication by a constant, and integration.

By appropriately interconnecting these units and adjusting their parameters, a variety of complex physical systems may be simulated.

Behaviour of system variables can be monitored and plotted by the student.



Why was PAC Developed

The modular PAC (Personal Analog Computer) system was developed to provide students with a model intermediate between a dynamic physical system and the mathematical representation of that system.

After a student learns the physical features of a system, and the differential equations governing the system, he can interconnect PAC units to represent that system (or the equation). The Units will duplicate in real time the behaviour of the system variables.

PAC units provide the student with a personal experience associating physical behaviour with the solutions of a differential equation. They permit him to test his knowledge on a direct model personally at any time and in any place. This experimentation will reinforce both his physical and mathematical understanding.

Specifications

There are four PAC modules: ADDER, INTEGRATOR, COEFFICIENT MULTIPLIER, and the CONTROL UNIT.

Accuracy 1%

Panels Each module has a graphic panel face which indicates its mathematical operation. Panels are white and take crayon easily for marking purposes.

Interconnection Units are physically and electrically connected by four gold plated connectors. These carry power and control signals.

Variables Variables are interconnected by miniature banana patch cords.

Parameters Each unit has a front panel control to adjust its parameters.

Power Portable power is contained in the Control Unit.

Read Out Large center position precision meter, permits the measurement of any variable.

Figure 1; shows a typical physical system that a student might want to analyze, that of a spring and mass.

The parameters are the spring constant and the mass is assumed to be 1 for simplicity. The variables are x, displacement and f, force between the mass and the spring.

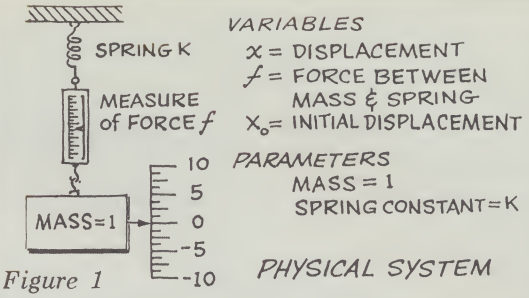


Figure 1

Figure 2; shows the differential equations that he would write showing the initial position of the mass displaced an amount X_0.

Figure 2

$$-Kx = \frac{d^2x}{dt^2} \qquad \begin{matrix} t = 0 \\ x = X_0 \\ dx/dt = 0 \end{matrix}$$

DIFFERENTIAL EQUATION

Figure 3; shows the interconnection of PAC units. Each patch cord is a variable. Each box is a mathematical operation. The student sets the Coefficient Multiplier to the spring constant, the middle inegrator to X_0 as an initial condition, and the first Integrator to zero, meaning that the initial velocity is zero.

Pushing the SET switch on the Control Unit sets up this initial situation. Pushing the HOLD switch down starts the problem running and the X variables will follow the sine wave shown in the graph. Pushing the HOLD switch up causes the problem to run in ¼ second intervals.

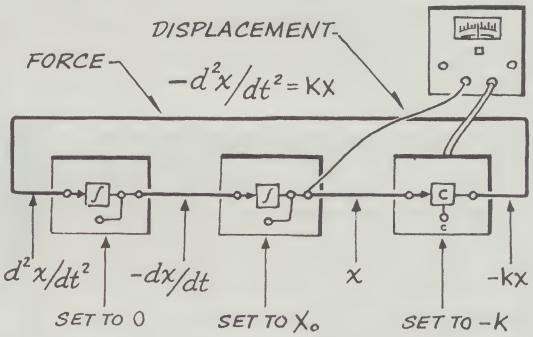


Figure 3 PAC UNITS

Figure 4; whenever the student puts the HOLD switch in the neutral position, the problem is frozen and reading and plotting of variables can take place. This then is the resulting graphic solution.

Figure 4 GRAPHIC SOLUTION

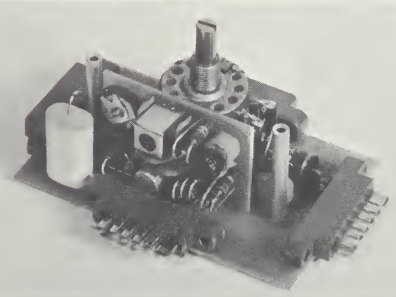
The Integrator Unit, a typical PAC element

The integrator Unit is shown in Figure 6 without cover to indicate the packaging and precision components. Note particularly:

Precision Mylar condensor for integrating current
Two high-speed sealed reed relays for control
All printed-circuit transistorized construction
Large, high resolution potentiometer
Miniature transistorized operational amplifier

What does the PAC unit contain?

The PAC arithmetic units are highly engineered electronic circuits. Each unit contains an operational amplifier with an open loop gain of 1,000 and feedback components to perform the arithmetic operation. Every unit is pretested and calibrated to better than 1% accuracy.



The standard complement of PAC units consist of two Integrators, two Coefficient Multipliers, an Adder, and a Control Unit. Aside from the ordinary first and second order differential equations, PAC units are useful in demonstrating nonlinear differential equation solution, nonlinear circuits such as flipflops, multivibrators, waveform generators, and a number of interesting numerical experiments.

For further information or advice on applications, write or phone
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